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Decomposition of filter paper and herbage in meadows of the high Sierra Nevada: preliminary results

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Weight lost by filter paper and native herbage is being studied on five meadows in the Sequoia National Park, California, to develop an index to rate of herbage decomposition. Some samples are buried 5 cm deep; others are placed on the surface. All samples are left in place for 1 year. First year results show that the herbage samples provided better estimates of mean losses than the filter paper samples. Weight lost by unburied herbage ranged from 50 to 75 percent, depending on the test site. These results are provisionally acceptable as an index to rate of herbage decomposition.

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Historically, mountain meadows of the high Sierra Nevada have been grazed by domestic as well as wild herbivores. Continued overuse has resulted and can be expected to result in deterioration of meadow lands. Proper use and maintenance of these high-country meadows may be related to rate of herbage decomposition.

Several investigators have reported benefits from leaving some amount of the current herbage.[1] The 50-50 rule (graze half–leave half) has often been used as a guide to conservative rangeland use.[2] A key but largely unanswered management question is: What proportion of the current herbage production should be left to decompose (left unconsumed by herbivores) in order to maintain or improve meadow ecosystems?

To help find an answer, I began a study of weight loss by filter paper and native herbage at five meadow sites in Sequoia National Park, California. Objective of the study is to develop indexes to rates of decomposition for meadow herbage. The concept upon which the study is based is that the proportion of each year's herbage production which must be left equals the amount of the average annual production which will decompose in a year's time.

The first year's results of a 3-year study suggest that, among the treatments being tested, samples of unburied herbage provide the best index to decomposition rates.

STUDY SITES

Five meadow sites in Sequoia National Park were selected for study in September 1972:

Site 1–Dominant species: Short-hair sedge (*Carex exserta*)–hereafter referred to as hair sedge. Location: Slope, Little Five Lakes area. Elevation: 10,315 feet (3,094 meters).

Site 2–Dominant species: Shorthair (*Calamagrostis breweri*) and *Carex subnigricans*. Location: Lake shore, Little Five Lakes area. Elevation: 10,410 feet (3,123 meters).

Site 3–Dominant species: Shorthair. Location: Large open meadow on Chagoopa Plateau. Elevation: 10,160 feet (3,048 meters).

Site 4–Dominant species: Tufted hairgrass (*Deschampsia caespitosa*). Location: Small opening in Big Arroyo. Elevation: 9,200 feet (2,760 meters).

Site 5–Dominant species: Beaked sedge (*Carex rostrata*). Location: Sky Parlor Meadow on Chagoopa Plateau. Elevation: 9,120 feet (2,736 meters).

METHODS

Three transects were set out within each site. They were placed so each is representative of the site and all are as nearly alike in cover and species composition as possible. This was done to control within-site variables that could mask yearly variations in decomposition.

One of the three transects was randomly selected for study in 1972-73. Ten completely randomized blocks were set out along the transect. Each block was 1 square foot (0.09 sq. meter), and the blocks were about 1 meter apart.

One of these combinations of type of sample material and position of placement was randomly assigned to each quarter of each block:

1. Two circles of cellulose filter paper buried 5 cm deep.
2. Two circles of cellulose filter paper unburied.
3. Native herbage (from the block) buried 5 cm deep.
4. Native herbage (from the block) unburied.

Therefore, each of the five sites had 10 replications of each type of material and placement. The materials were left in place for 1 year (September 1972 to September 1973).

The filter papers were 9-cm circles of Whatman No. 1. Native herbage on each block was clipped and mixed in the bag. Subsamples (each about one-third of the material) were returned to the blocks from which they came. Generally, the herbage was mature; however, seed shatter was not advanced and, except on the hair-sedge site, some forbs were still flowering.

Filter papers and herbage were placed in individual nylon net bags to facilitate recovery. The nylon net used for the bags had a 1- to 2-mm mesh.

In general, I followed the procedures outlined in the recommendations of the U. S. International Biological Program Grassland Biome.[3]

Green weights of the herbage left to decompose were corrected for moisture and ash contents by using the remaining herbage from each block. Filter papers were not corrected for ash because of the small amounts (0.00033 g/circle).

Recovered sample weights were corrected for any adhering soil particles; i.e., mineral matter and soil organic matter. Net recovered weight was subtracted from the net original weight, and the percentage of weight loss was computed.

Percentages of weight loss were changed to their corresponding angles by arcsin transformation[4] for analysis. Results from each meadow site were individually analyzed by two-way analysis of variance. The columns were the 10 blocks, and the rows the four combinations of sample type (filter paper or herbage) and placement (buried or unburied). Tukey's test[4] was used to detect differences among means.

RESULTS AND DISCUSSION

First-year results indicate that herbage samples provide better estimates of mean losses than filter paper samples. Unburied herbage lost from 50 to 75 percent and buried herbage 49 to 84 percent of initial weights, depending on site (*table 1*). Losses from unburied and buried filter papers ranged from 17 to 59 and 22 to 91 percent respectively.

The results (*table 1*) compare favorably with those reported by others. For filter papers buried 5 cm deep and left in the field for 279 days, Clark[5] reported losses of 74.6 percent; and for 300 days, he reported losses of 84.6 percent. And for buried herbage material, he reported a loss of 51.5 percent after 133 days exposure from mid-May to late September.

Table 1–*Weight losses by filter paper and native herbage samples on five meadow sites, Sequoia National Park, California, 1972-73*

Meadow site	Sample type and placement			
	Filter paper buried	Filter paper unburied	Native herbage buried	Native herbage unburied
	Percent			
Hair sedge	54.2	28.9	50.9	54.6
Shorthair (Lake Shore)	22.1	17.7	49.0	50.0
Shorthair (Large Meadow)	85.3	58.8	64.2	55.5
Tufted hairgrass	90.6	51.4	55.7	52.3
Beaked sedge	72.3	14.6	84.1	74.7

Table 2—*Arcsin transformations ($\bar{X}$) corresponding to proportions of sample weights lost and standard errors of the means (SE) on five meadow sites, Sequoia National Park, California, 1972-1973, by sample type and placement*

Meadow site	Sample type and placement								Tukey's test "D"	Analysis of variance F-ratios[1]
	Filter paper buried		Filter paper unburied		Native herbage buried		Native herbage unburied			
	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE	$\bar{X}$	SE		
Hair sedge	47.3 a[2]	4.4	31.7 b	3.2	45.4 a	2.8	47.6 a	2.5	11.5	6.63
Shorthair (Lake Shore)	25.7 b	4.5	23.4 b	3.4	44.4 a	1.2	45.0 a	1.5	11.3	16.10
Shorthair (Large Meadow)	68.7 a	2.7	51.2 b	4.9	53.3 b	1.4	48.2 b	1.4	11.2	10.02
Tufted hairgrass	72.9 a	2.6	46.0 b	5.0	48.3 b	1.1	46.3 b	1.7	12.5	19.12
Beaked sedge	59.1 b	3.1	21.7 c	2.3	66.6 a	1.0	59.8 b	0.9	6.8	136.40

[1] F-ratios, for sample type and placement, were statistically significant at the 5 percent level of probability (F.95(3,27)=2.96).

[2] Means followed by unlike letters in row differ significantly at the 5 percent level of probability by Tukey's test "D."

Losses of 34 to 45 percent from litter bags containing different kinds of deciduous tree litter were reported by Kelly.[6] His study covered a 16-month period, with the litter bags placed on the surface. Over all meadow sites, my results with unburied filter paper (34.3 percent) were similar to his.

With 10 values considered in the means, the standard errors (*table 2*) ranged from 1-1/2 to 17-1/2 percent of the means. In the light of the standard errors and the results of other investigators, I believe the procedures are producing reasonably accurate data.

These procedures do not, however, directly measure the rates of decomposition. Rather, they measure the suitability of the ambient environment for microbial activity.[5] And the results are from introduced and artificial materials. But the results do provide a relative index to decomposition. The index depends upon the type and placement of sample material used; its value depends upon how nearly the results correspond to actual decomposition on a site.

The standard errors of the means (*table 2*) for buried and unburied herbage differed only slightly. None of them exceeded 6-1/2 percent of the means. And with one minor exception, the percentages were lower than their corresponding values for filter papers. These results suggest that the herbage samples provided somewhat better estimates of their means than the filter paper samples.

The proportions of weight lost by buried and unburied filter papers were significantly different on every site except the lake shore (*table 2*). Regardless of placement, filter paper losses there were less than the herbage losses. Buried and unburied herbage differed in proportion of weight lost only on the beaked sedge site, and this difference was a borderline case. On two sites, proportions of weight lost by buried filter papers exceeded losses from herbage. But this relationship was not true for unburied filter paper losses.

CONCLUSIONS

The use of native herbage appears to provide a fairly consistent and conservative index to decomposition. Unburied samples do not appear to have any advantages over buried samples. But, since herbage is naturally deposited on the surface, placement there may yield values more closely related to actual decomposition. And so I have provisionally accepted the results from unburied native herbage as an index to decomposition.

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NOTES

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